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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : G10H 3/18, 3/00

A1

(11) International Publication Number: WO 91/15844

(43) International Publication Date: 17 October 1991 (17.10.91)

(21) International Application Number: PCT/US91/02340

(22) International Filing Date: 4 April 1991 (04.04.91)

(30) Priority data:
504,939 5 April 1990 (05.04.90) US

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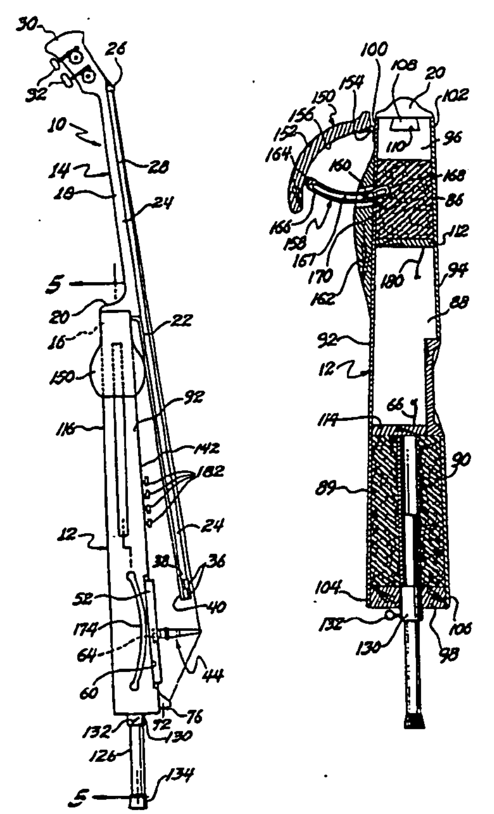
(81) Designated States: AT, AT (European patent), AU, BB, BE (European patent), BF (OAPI patent), BG, BJ (OAPI patent), BR, CA, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CM (OAPI patent), DE, DE (European patent), DK, DK (European patent), ES, ES (European patent), FI, FR (European patent), GA (OAPI patent), GB, GB (European patent), GR (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC, MG, ML (OAPI patent), MR (OAPI patent), MW, NL, NL (European patent), NO, RO, SD, SE, SE (European patent), SN (OAPI patent), SU, TD (OAPI patent), TG (OAPI patent), US.

Published
With international search report.

(54) Title: ELECTRONIC UPRIGHT BASS

(57) Abstract

An electronic upright bass (10) produces sound closely approximating the sound produced by an acoustic upright bass. The bass includes a body (12) defining compartments (86, 88, 90) and slots (174, 176) placing the compartments in communication with the exterior of the body. The compartments and slots permit the bass to operate like the top table and portals of an acoustic upright bass. Piezoelectric transducers (64) are located beneath the feet of the bridge (44) and, thus, convert the authentic vibration of the body to electrical signals for reproduction through an amplifier and speakers. Magnetic pickups (36) mounted beneath the strings (24) of the instrument provide the component of the sound corresponding to the pure clean vibration of the strings.



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ELECTRONIC UPRIGHT BASS

BACKGROUND OF THE INVENTION

The present invention relates to stringed instruments, and, in particular, to upright basses.

The acoustic upright bass has been in existence since the 16th century. Its sole purpose has been to provide a low sound and tonality that, prior to its introduction, could not be produced with other types of instruments existing at that time.

The acoustic bass produces sound from the vibration of the playing strings when they are plucked or bowed. The wooden bridge situated on the face or top table of the body of the bass, which supports the strings, transmits the vibrations of the strings to the top table, which creates pressure within the hollow body cavity of the bass. The pressure developed within the cavity forces air through the f-shaped holes or portals defined by the top table, which produces sound. Due to the size of and degree of tension maintained on the strings, and the configuration and size of the bass body, the acoustic bass produces a deep, "round" sound.

Although it has always been difficult to manipulate and transport, due to its size, the sound production of the acoustic upright bass proved satisfactory through the years. The environment in which the acoustic bass has been used has changed, however. Audiences and theaters have tended to increase in size. Additionally, bass players found themselves performing with musicians playing electronically amplified instruments at sound levels that masked the sound produced by the acoustic bass. Finally, the wide variety of styles of music played with electronically enhanced instruments required some adjustment to the tonal quality of the sound produced by the bass. Bass players soon found that the sound produced by an acoustic bass was no longer adequate, and that provision had to be made to increase its volume and adjust the tonal quality of the sound it produced.

Initially, bass players attempted to increase the level of sound produced by the acoustic bass by mounting a microphone on the body of the bass near its portals. This approach enjoyed the benefit that the body of the bass continued to contribute to the unique sound produced. Also, the microphone provided the ability to increase the level of sound produced by the bass. However, the bass often created "feedback," due to sound traveling between the microphone and the amplifier employed to amplify the sound produced by the bass. Additionally, the amplifier increased the level of other unwanted sounds picked up by the microphone. For example, sound made by other musicians performing with the bass player and audience generated sounds commonly were picked up by the microphone and amplified by the amplifier. Of course, an acoustic upright bass mounted with a microphone remained difficult to manipulate and transport due to its size. Moreover, the tonal quality of the sounds produced by the instrument could not be adjusted at the bass and had to be adjusted, to the extent it could be adjusted, at the amplifier.

Magnetic pickups were also employed to amplify sound produced by the bass. As is known to those in the art, magnetic pickups generate a magnetic field around the strings of a stringed instrument. The vibrating strings create a signal that is used by signal processing equipment to reproduce the sound produced by the strings. However, magnetic pickups cannot reproduce with any accuracy the unique contribution to the sound produced by the vibrating body of the bass. Therefore, acoustic basses fitted with pickups proved inadequate.

With the introduction of the electric bass guitar, bass players acquired an instrument that was capable of producing low-toned sound, and which was relatively easily transported. Magnetic pickups mounted on the body of the bass guitar provided suitable amplification. However, like the acoustic bass fitted with pickups, the bass guitar possessed only a limited ability to adjust tonal quality. Because its size and shape was quite

similar to a lead guitar, it was easily manipulated. However, the electric bass guitar was not embraced by traditional acoustic bass players because, due to the elimination of the acoustic body, the guitar could not provide the same sound as that produced by an acoustic bass. Further, the "feel" of the bass guitar was not the same as the acoustic bass. Thus, the technique used to play the acoustic bass was not transferable to the electric bass guitar due to the different configurations of each instrument.

Therefore, in a continuing effort to provide traditional bass players with an instrument that simulated the feel and sound of an acoustic upright bass, yet produced an adequate sound level and tonal control, workers in the art mounted transducers to the acoustic bass. Generally, and as is known in the art, a transducer is a piezoelectric quartz crystal that converts mechanical vibration to electrical signals. The transducers were mounted to the bridge of the bass and converted movementof the bridge and bass body to electrical signals that were converted to sound. This technique was superior to mounting a microphone to the bass since transducers are not as sensitive as a microphone to unwanted noise, and since the contribution by the vibrating bass body to the tonal quality of the sound was picked up by the transducers. Therefore, an acoustic bass equipped with transducers more accurately produced the sound typical of an acoustic bass, and effectively produced a higher level of sound than could be produced by a bass mounted with a microphone. However, electronic circuitry for control of tonal quality could not be easily or effectively mounted to the bass, and, thus, the musician did not have control over the tonal quality at the bass. Over time, the ability to shape the sound produced by the bass, and by many other instruments used by musicians during performances, became more critical. Commonly, the size and nature of the room in which musicians perform, the size of the audience, the nature of the instruments used during the performance and the number of the musicians performing will affect the tone that a bass player wished to produce during a

performance. Additionally, the variety of pieces performed commonly necessitates adjustments to tonal quality during a performance. Accordingly, acoustic basses mounted with transducers did not provide a complete solution for traditional bass players.

A compromise between an amplified acoustic bass and the electric bass guitar was reached with the Ampeg "baby bass." The baby bass looked like an acoustic upright bass, but was scaled down in size by 50%. The body of the baby bass was plastic and filled with foam, and had an aluminum bridge on which transducers were mounted, which together prevented the baby bass from producing sound closely approximating that produced by an acoustic bass. Although the baby bass gained acceptance among some types of musicians, traditional acoustic bass players were not satisfied with the sound it produced and the limited degree to which tonal quality could be adjusted. Further, the baby bass did not provide the feel of an acoustic upright bass.

Accordingly, workers in the art produced the generation of electronic upright basses that is currently in existence and being marketed today. The contemporary electronic upright bass employs a relatively slim elongated body on which the components of the bass are mounted. Accordingly, the electronic upright bass is more easily transportable and more rugged than the acoustic bass. The components mounted on the body commonly include the playing strings, bridge, transducers, fingerboard and neck, and, in some instances, magnetic pickups. The electronic upright bass provides sound that more closely approximates the sound produced by an acoustic upright bass than the sound produced by its predecessors, and provides "on-board control" of tonal quality. That is, it provides the musician with the ability to adjust tonal quality using controls mounted on the bass. The electronic upright bass also more closely approximates the physical configuration of the acoustic bass, and, therefore, classical techniques learned and used by acoustic bass players are more readily transferable to the electronic upright bass.

However, the sound produced by the electronic upright basses still is not as close to the sound produced by an acoustic upright bass as it could be. Commonly, electronic upright basses still employ transducers mounted in the bridge. With the exception of the playing strings, the bridge is the component of the bass that is the most sensitive to mechanical vibration. Accordingly, extraneous and unwanted sounds produced during play of the instrument by contact with the fingerboard, neck, strings, and bridge are transmitted to the bridge and reproduced through the speakers. Additionally, as understood by applicant at this time, the bodies of known electronic upright basses are solid. That is, the bodies are hollow and completely filled with foam. Therefore, there is little or no contribution made by the vibrating body to sound production corresponding to the contribution made by the vibrating body of the acoustic bass. The basses, thus, produce a sound different from the acoustic upright bass. Additionally, the neck and fingerboards of several known electronic upright basses are not mounted to the body at the same angle at which the fingerboard of the acoustic upright bass is mounted. Therefore, in those cases, traditional acoustic upright bass players must adapt their style and technique to use an electronic upright bass. In general, most known electronic basses are simply extensions of the electric bass guitar.

Therefore, there remains a need for an electronic upright bass that provides effective sound amplification and tonal control, that is less bulky and more portable than an acoustic upright bass, and that produces sound like that produced by an acoustic upright bass.

SUMMARY OF THE INVENTION

The present invention provides a stringed instrument including a body and at least one playing string mounted to the

body to permit the string to produce sound when it is vibrated. The instrument also includes a bridge that contacts the string for transmitting vibration from the string to the body through at least one foot defined by the bridge. The instrument includes apparatus located at the foot of the bridge for converting mechanical vibration to an electrical signal.

The present invention also provides a stringed instrument including a body defining at least one hollow compartment and an opening that places the compartment in communication with the exterior of the body. At least one playing string is mounted to the body to permit the string to produce sound when it is vibrated. A bridge contacts the string and transmits vibration from the string to the body. Apparatus is provided for converting mechanical vibration produced by the string to an electrical signal.

BRIEF DESCRIPTION OF THE DRAWINGS

The following detailed description of the preferred embodiments can be understood better if reference is made to the attached drawing, in which:

FIG. 1 is a front view of the electronic upright bass constituting the preferred embodiment of the present invention;

FIG. 2 and 3 are side views of the bass shown in FIG. 1;

FIG. 4 is a bottom view of the bass shown in FIG. 1;

FIG. 5 is a front sectional view of a portion of the bass shown in FIG. 2, taken along the line V-V;

FIG. 6 is a side sectional view of a portion of the bass shown in FIG. 1, taken along the line VI-VI;

FIG. 7 is a bottom sectional view of the bass shown in FIG. 1 taken along the line VII-VII;

FIG. 8 is an exploded view of the bridge and transducer assembly for the bass shown in FIG. 1;

FIG. 9 is a side view of part of the bass shown in FIG. 1, showing the area of the bass in the vicinity of the bridge assembly;

FIG. 10 is a bottom sectional view of the bass shown in FIG. 1 taken along the line VII-VII;

FIG. 11 is a perspective view of the portion of the bass shown in FIG. 1 in the vicinity of the bridge assembly;

FIG. 12 shows part of an electronic upright bass constituting an alternate embodiment of the present invention, in the vicinity of the bridge assembly;

FIG. 13 is a bottom sectional view of the apparatus shown in FIG. 14, taken along the line XIII-XIII;

FIG. 14 is a side view of the portion of the apparatus shown in FIG. 12;

FIG. 15 is a schematic diagram of a signal processor useful with the apparatus shown in FIGS. 1 through 14; and

FIG. 16 is a schematic diagram of another signal processor useful with the apparatus shown in FIGS. 1 through 14;

FIG. 17 is a schematic diagram of another signal processor useful with the apparatus shown in FIGS. 1 through 14.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIGS. 1 through 4 show an electronic upright bass 10, which constitutes the preferred embodiment of the present invention. Bass 10 can be used with any suitable circuitry (for example, the circuits shown in FIGS. 15, 16, or 17) that processes the signals produced by bass 10. Bass 10, when used with a suitable circuit, provides traditional acoustic bass players with the sound and feel of an acoustic upright bass. That is, the design of the body of bass 10 and the manner of mounting the transducers to bass 10 permit bass 10 to produce sound closely simulating the sound produced by an acoustic upright bass. Further, the physical configuration of bass 10 provides a traditional bass player with the feel of an acoustic upright bass. That is, the physical layout of bass 10, including the placement of its fingerboard, and the provision of a stomach rest, permits a traditional acoustic upright bass player to play bass 10 in the same manner as an acoustic upright bass.

Bass 10 includes a body 12 to which the components of bass 10 are mounted. A neck assembly 14 is mounted to top 16 of body 12. As is explained in more detail below, a dovetail joint is employed to mount neck assembly 14 to body 12. Body 12 is constructed of wood and, preferably, poplar.

Neck assembly 14 includes neck 18, which is mounted to top end 16 of body 12. Neck 18 supports the remaining components of neck assembly 14. Neck 18 is constructed of wood, preferably maple or poplar. Neck 18 defines base 20 at which neck 18 is mounted to body 12, and elongated segment 22, which supports an elongated fingerboard 24. Fingerboard 24 is constructed preferably of rosewood, and is a conventional fingerboard of the type that would be found in an acoustic upright bass. Neck 18 is so constructed and mounted to body 12

that the angle formed between fingerboard 24 and the longitudinal axis of body 12 falls with the range commonly found in acoustic upright basses. Preferably that angle is between about 6 degrees and 8 degrees. The angle shown in FIG. 2 is 6.5 degrees. A conventional nut 26 is secured to neck 18 adjacent end 28 of fingerboard 24. A gearbox 30 is formed at the end of neck 18. Gearbox 30 serves as a mounting for machine heads 32 and a mounting location for one end of each of playing strings 34. Generally, neck assembly 14, including machine heads 32 and gearbox 30, is identical to the neck assembly found on a conventional acoustic upright bass.

A pair of magnetic pickups 36 is mounted with bracket 40 to end 38 of neck segment 22 and fingerboard 24. Magnetic pickups 36 can be of any type commercially available for use with electric lead or bass guitars. Magnetic pickups 36 are mounted to ensure that their active faces are generally parallel with strings 34. As can be seen best in FIG. 4, playing strings 34 are not coplanar, due to the curve of bridge 42. Accordingly, each magnetic pickup 36 should be suitably mounted on bracket 40 to orient its active surface to be parallel with a pair of strings 34. Bracket 40 is secured to segment 22 and fingerboard 24 and magnetic pickups 36 are secured to bracket 40 in any known suitable manner.

Bass 10 includes a bridge assembly 44, which includes a suitable conventional wooden bridge 42. Bridge assembly 44 also includes a pair of feet 46, a pair of threaded bolts 48 and a pair of threaded adjusters 50. Each of feet 46 rests on the top surface of a runner or slide 52 or 54. Each head 56 of bolt 48 rests within a cutout defined in a foot 46. Preferably, each cutout in foot 46 is so configured as to prevent rotation of head 56 when adjusters 50 are threaded on bolts 48. Adjusters 50 are adapted to be threaded onto the shafts of bolts 48. Bridge 42 defines a pair of openings 58 which are sized to receive the shafts of bolts 48. Runners 52 and 54 are mounted within cutouts 60 and 62, respectively,

which are defined by body 12. Feet 46 rest on the upper surfaces of runners 52 and 54. Adjusters 50 are disposed between feet 46 and bridge 42 on the shafts of bolts 48. Bridge 42 rests on the upper surfaces of adjusters 50. Runners 52 and 54 are preferably constructed from particle board, and are 5/8 of an inch thick and 1½ inches wide. Bass runner 52 is 12 inches long and treble runner 54 is 8 inches long. A transducer 64 is embedded within each runner 52 and 54 approximately equidistant its ends. Each transducer is embedded in a cutout formed in runner 52 or 54, and covered with epoxy. Electrical leads 180 run along segment 222 and into body 12 to provide electrical communications between transducers 64 and the processing circuit in body 12. Each of feet 46 is mounted on a runner 52 or 54 directly over transducer 64. None of the components of bridge assembly 44, or runners 52 and 54, are permanently secured to each other or to body 12. Runner 52 and 54 are not permanently mounted to cutouts 60 and 62. As with an acoustic upright bass, the tension on playing strings 34 forces bridge 42 and the remaining components of bridge assembly 44 against body 12. Thus, bridge assembly 44 and runners 52 and 54 are maintained in place by the tension on strings 34.

Transducers 64 are conventional and readily commercially obtainable. They are piezoelectric crystals that convert mechanical motion to electrical signals. The signals are carried from transducers 64 along wire 66 to a signal processor located on a circuit board (not shown) located within body 12. Sound shaping is achieved by the circuit contained in body 12 by processing the signals produced by magnetic pickups 36 or transducers 64, depending on the type of signal processor chosen. Sound shaping includes volume control and tone or frequency control, for example, treble and bass.

Four conventional bass playing strings 34 are provided to produce the vibration that is converted to audible sound by bass 10. Strings 34 are secured at end 68 to conventional

machine heads 32, and at end 70 to tailpiece 72 in the normal fashion. Machine heads 32 are used to tighten strings 34 and tune them as desired. The tension on strings 34 maintains bridge assembly 44 and runners 52 and 54 in place. Strings 34 are held in place at tailpiece 72 in the normal fashion. That is, the end 68 of each string 34 is threaded through an opening 74 (only 1 of 4 shown) formed in tailpiece 72 until metal button 76, which is secured to end 70 of string 34, contacts tailpiece 72. String 34 is located in the corresponding groove 78 formed in bridge 42, then located in the corresponding groove formed in nut 26 and threaded into the shaft of the corresponding machine head 32. Machine head 32 is employed to apply appropriate tension to string 34. Tailpiece 72 is secured to body 12 in any suitable fashion. Thus, tailpiece 72 can be glued to body 12 and further secured with screws 80. it should be noted that the dimensions of cutouts 60 and 62 are larger than runners 52 and 54 to permit positioning of runners 52 and 54 without contacting the walls of cutouts 60 and 62. Additionally, runners 52 and 54 may be slid in the directions indicated by arrows 82 and 84, respectively, to permit tuning of bass 10. It should be noted, however, that feet 46 always should be located directly over a transducer 64.

The configuration of body 12 contributes to the ability of bass 10 to closely approximate the sound produced by an acoustic upright bass. In particular, the large, hollow body of an acoustic bass vibrates as the instrument is played. The portals formed in the top table of the acoustic bass body enhance the vibration of the body. The vibrating top table give the acoustic upright bass its deep, round tone. Accordingly, although body 12 of bass 10 has been given a slim configuration to enhance portability, it has been provided with interior compartments and portals. The compartments and portals enhance the vibration of body 12 when bass 10 is played and, similar to an acoustic upright bass, the enhanced vibration contributes favorably to the tonal quality of the sound produced by bass 10.

Body 12 defines generally three compartments 86, 88 and 90. The shell of body 12 is formed by sides 92 and 94, dovetail block 96, lower block 98, body front 142, and body back 116, all of which are constructed of suitable wood, preferably poplar. Ends 100 and 102 of side pieces 92 and 94, respectively, are secured to opposing sides of block 96 with glue. Similarly, ends 104 and 106 of sides 92 and 94, respectively, are secured to opposing sides of lower block 98 with glue. A dovetail 108 is formed on the end of neck base 20 of neck 18, and a corresponding dovetail groove 110 is formed in dovetail block 96. Dovetail 108 is slid into and glued within dovetail groove 110 to secure neck assembly 14 to body 12. A spacer 112 is glued between sides 92 and 94 to form compartment 86. Compartment 86 is filled with a polyurethane insulating foam 87. A second spacer 114 is glued to sides 92 and 94 to form compartments 88 and 90. Spacers 112 and 114 can be formed from poplar. Body back 116 is glued to ends of dovetail block 96, spacer 112, spacer 114, and lower block 98 to partially enclose compartments 86, 88 and 90. Back 116 also can be formed from poplar. Posts 118 and 120 are secured to back 116 to support a tube 122. Post 118 is glued to back 116 and spacer 114, and post 120 is glued to back 116 and lower block 98. Each end of tube 122 rests on a post 118 or 120. Passage 124 defined by tube 122 is sized to receive an extension 126. Lower block 98 defines a passage 128 which is adapted to receive a portion of collar 128. Extension 126 passes through the passage defined in collar 128 and passage 124 of tube 122. The position of extension 126 within passage 124 and, accordingly, the length of extension 126 that extends from collar 130 can be established by appropriately positioning extension 126 within passage 124 and rotating wingnut 132 until its shaft is tightened against extension 126. The shaft of wingnut 132 extends through an opening formed in collar 130. Accordingly, the height of bass 10 can be adjusted by loosening wingnut 132, positioning extension 126 within passage 124, and tightening the shaft of wingnut 132 against extension 126. A

rubber foot 134 is placed over the end of extension 126 to resist slippage of extension 126 along the floor.

A corrugated cardboard separator 134 is mounted within compartment 90. The edges of sides 136 and 138 of separator 134 are so secured to sides 92 and 94 that top 140 of separator 134 are so secured to sides 92 and 94 that top 140 of separator 134 will contact the lower surface of body top 142 when top 142 is mounted in place. With top 142 in place, it and body sides 92 and 94 and body back 116 form three subcompartments 144, 142 and 148 within compartment 90. Subcompartments 144 and 146 are formed at the forward corners of body 12 between separator 134 and the shell of body 12. Prior to securing body top 142 in place, polyurethane insulating foam 89 is injected into subcompartment 148, which fills it completely, with the exception of the interior of tube 122. The ends of tube 122 abut spacer 114 and block 98 to prevent insulating foam from reaching the interior of tube 122. Subcompartments 144 and 146 remain empty. Hollow subcompartments 144 and 146 permit body 12 to vibrate in a way that permits bass 10 to more closely approximate the sound produced by a traditional acoustic upright bass.

A stomach rest assembly 150 is mounted to body 12. Stomach rest 152 of assembly 150 simulates the shape of that portion of the body of a traditional acoustic upright bass against which the stomach of the bass player rests when playing the bass. The position of rest 152 is adjustable. Stomach rest 152 is secured to end 100 of body side 92 with a conventional door hinge 154. One plate of hinge 154 is secured to surface 156 of rest 152, and the remaining plate is secured to end 100 of body side 92. Pivoting and positioning of rest 152 is controlled using conventional desk hinge 158. Pin 160 of hinge 158 is secured in shelf 162 formed on side 92. Hinged end 164 of hinge piece 166 is secured to surface 156 in any suitable manner. Slot 167 receives bolt 160. End 168 extends into compartment 86 through an opening 170 defined by body side

92. The ends of slot 167 and bolt 160 operate to define the limits of movement of rest 152. Rest 152 is pivoted until its desired position is reached, and a wingnut 172 is threaded onto bolt 160 and tightened against shelf 162 to secure rest 152 in position.

Body 12 defines a pair of slots 174 and 176. Base slot 174 is formed in side 92 near bridge assembly 44. Similarly, treble slot 176 is formed in side 94 near bridge assembly 44. Slots 174 and 176 permit body 12 to vibrate in a manner similar to that of the top table of a traditional acoustic upright bass. Therefore, slots 174 and 176 contribute to bass 10 approximating closely the sound produced by an acoustic upright bass. Conventional control knobs are mounted in front 142 in any desired known manner. The control knobs 182 are suitably connected to the circuit in body 12 and are used to make any volume or tone adjustments permitted by the circuit. The number of knobs required will depend on the type of circuit chosen. A conventional jack 178 is provided to connect the circuit to an external amplifier.

FIGS. 12 through 14 show an electric upright bass 200 that constitutes an alternate embodiment provided by the present invention. The entire bass 200 has not been shown since it is identical to bass 10, with the exception of details shown in the drawings and additional exceptions noted below. Accordingly, only the exceptions will be described.

Initially, it should be noted that body 212 does not include spacers similar to spacers 112 and 114 of bass 10. Body 212 of bass 200 consists of only one compartment, and that compartment is filled entirely with polyurethane insulating foam. Also, as can be seen from FIGS. 12 and 14, there are no openings similar to slots 174 and 176 in body 212. Accordingly, bass 200 does not benefit from the acoustic properties inherent in body 12 of bass 10.

Runners 52 and 54 have been replaced in bass 200 with mounting block 252, which is formed from particle board. Mounting block 252 rests on the upper surface of body 212. A pair of transducers, not shown, are embedded in mounting 252 below feet 256 of bridge assembly 244. Bass 200 includes a conventional jack 278 to allow connection with an external amplifier.

Any suitable known signal processing circuit can be used or easily constructed to control the volume and shape of the sound produced by basses 10 and 200. Generally, the circuit receives and processes the signals produced by the transducers and magnetic pickups. Regardless of the type of processor chosen, the signals produced by transducers 64 must be amplified, preferably by an operational amplifier. A 9-volt power source can be provided for the operational amplifiers in any suitable fashion, but preferably is supplied by a 9-volt battery mounted within body 12 proximate the signal processor circuit board. Treble and bass tone control can be provided using a suitable filter. Generally, the signals produced by the magnetic pickups and the transducers are summed together with the summing amplifier before their signal is provided to output jacks 178 or 278 and the amplifier.

FIGS. 15, 16 and 17 show three signal processing circuits suitable for processing signals produced by basses 10 and 200. Circuit boards containing the signal processing circuitry can be placed in any suitable location in or on the bodies of basses 10 and 200. However, it is preferable that back 116 be provided with an access plate to permit access to compartment 88, and that the circuit be mounted within compartment 88. Similarly, the back of body 212 of bass 200 can be provided with an access plate, and the circuit board can be mounted anywhere within body 212.

Figure 15 shows signal processor 400, which can be used to control the volume and shape of sound produced by

basses 10 and 200. Circuit 400 allows two adjustments, volume and tone and switching between transducers and pickups. Therefore, only three knobs 182 would be mounted on bass front 142. Treble transducer 402 (the transducer located on the treble side of the bass) and bass transducer 404 (the transducer located on the bass side of the bass) produce electrical signals representative of the vibration of the bass bridge and body and, accordingly, its strings. The signals produced by treble transducer 402 and bass transducer 404 are transmitted to an amplifier 414 along lines 408, 412 and 410 where the signals are boosted to a level suitable for further processing. Signals produced by magnetic pickups 422 and amplifier 414 are transmitted to switch 406 along lines 424 and 420, respectively. Switch 406 is a conventional switch, and permits either or both signals produced by amplifier 414 and pickups 422 to be input to summing amplifier 418 along lines 416 and 417. Summing amplifier 418 produces on line 426 the sum of the signals appearing on lines 420 and 424. Passive low pass filter 428 receives the signal produced by summing amplifier 418 on line 426. Low pass filter 428 permits rudimentary tone control by permitting the player to cut (decrease) or boost (increase) the amplitudes of frequency components above the high frequency setting of filter 428. The signal produced by filter 428 is transmitted to output jack 178 mounted in body side 94 of bass 10 or jack 278 mounted in side 294 of bass 200 through potentiometer 430, which provides volume control. A conventional cable can then be employed to input the signal produced by filter 428 and potentiometer 430 to a suitable amplifier. Potentiometer 430 can be adjusted to adjust the volume produced by bass 10 or bass 200. As indicated, 9 volt power is supplied to amplifiers 414 and 418.

Figure 16 shows a circuit 440 that electrically enhances the sound produced by an electronic bass. In particular, circuit 440 enhances the signals produced by transducers 402 and 404 to more closely approximate the sound produced by an acoustic upright bass. The signals produced by

treble transducer 402 are transmitted to an amplifier 442 along line 444. The signals produced by bass transducer 404 are transmitted to amplifier 446 along line 448. Amplifiers 442 and 446 boost the level of the signals produced by transducers 402 and 404 to a level suitable for processing by the remainder of circuit 440. The amplified signals produced by amplifiers 442 and 446 are transmitted to a crosspoint switch 450 along lines 452 and 454, respectively. Crosspoint switch 450 routes the signals appearing on lines 452 and 454 along lines 456 and 458. In one position, the signal on line 452 is routed to line 458 and the signal on line 454 is routed to line 456. In another position, the signal on line 452 is routed to line 456 and the signal on line 454 is routed to line 458. The signal appearing on line 456 is received by a variable phase shift network 460. Network 460 introduces a time delay into the signal appearing on line 456 by shifting its phase. This time delay operates to enhance some frequencies and cancel other frequencies when the signals are summed by amplifier 468, which contributes to producing tonal quality like that produced by an acoustic base. The signals produced by magnetic pickups 422 are received by shelving tone control network 462 along line 464. The low frequency setting of network 462 is typically 100 hertz and the high setting typically is 4.5 kilohertz, but both are a matter of design choice. Adjusting network 462 permits adjustment of the tone produced by the electronic bass. Network 462 provides two adjustments. The signal on line 464 can be cut or boosted below the low frequency setting, and cut or boosted above the high frequency setting. As indicated, 9 volt power is supplied to amplifiers 444, 448 and 468. The output of network 462 is produced on line 466. Summing amplifier 468 receives the signals appearing on lines 456, 458 and 466 and sums them together. The summed output signal appears on line 470 and is transmitted to jack 178 and 278. Potentiometer 472 is used to adjust the volume of sound produced. Potentiometer 474 and 476 are used at the time of manufacture to alter the balance by varying the level of the signals received by summing amplifier 468. Thus, circuit 440

provides four controls, volume, two tone controls, and transducer control provided by crosspoint switch 450. Thus, all four knobs 182 would be used with circuit 440.

FIG. 17 illustrates an additional circuit 480 useful for providing volume and tone control for basses 10 or 200. Amplifier 478 receives signals from the transducers along line 482 and produces its output on line 486. Amplifier 478 is used to adjust the level of the signal input to summing amplifier 487. Shelving tone control circuit 488 receives the signals produced by the magnetic pickups on line 489, and is used to adjust the tone of basses 10 and 200. Control 488 operates like control 462 shown in FIG. 16, and produces its output on line 491. The signal produced by amplifier 487 sums the signals on lines 486 and 491. Summing amplifier 487 is provided to jacks 178 or 278 through potentiometer 490 along line 492. Potentiometer 490 provides volume control. 9 volt power is provided to amplifiers 478 and 487 as indicated.

The operation of basses 10 and 200 should be apparent from the foregoing description. However, additional description follows.

Strings 34 are played in the normal fashion. That is, the player presses their fingers against fingerboard 24 along its length at locations that will produce sound having the desired tone. Strings 34 are plucked or bowed in the usual area above bridge assembly 44. The vibrations produced by strings 34 are transmitted to bridge assembly 44 and body 12 through bridge assembly 44. Vibrations are produced in body 12 very similar to those produced in the body of an acoustic upright bass due to the presence of subcompartments 144 and 146 of compartment 90 and slots 174 and 176. Vibrations from bridge 42 and body 12 are received by transducers 64 and converted to electrical signals on lines 66. Simultaneously, magnetic pickups 36 sense the vibration of strings 34 and produce corresponding electrical signals on lines 180. Lines

66 and 180 are connected to a suitable signal processing circuit, for example those appearing in FIGS. 15, 16 or 17, located in compartment 88 or, in the case of bass 200, within body 212. The signals produced by the signal processing circuit are transmitted to a suitable amplifier through jacks 178 or 278 for amplification and sound production. Transducers 64 provide signals representative of the mechanical vibrations produced in the top table and bridge of an acoustic upright bass. Magnetic pickups 36 provide signals corresponding to the pure vibrations of strings 34. Thus, pickups 36 contribute a crisp sound, and transducers 34 provide the deep, round sound, which together simulate the sound produced by an acoustic bass.

INDUSTRIAL APPLICABILITY

The way in which the present invention is capable of exploitation in industry and the way in which it can be made and used is deemed to be obvious from the description or nature of the invention.

What is claimed is:

1. A stringed instrument comprising:

a body;

at least one playing string mounted to said body to permit said string to produce sound when it is vibrated;

a bridge contacting said string for transmitting vibration from said string to said body through at least one foot defined by said bridge; and

means for converting mechanical vibration to an electrical signal, said converting means located at said foot of said bridge.

2. A stringed instrument comprising:

a body defining at least one hollow compartment and an opening that places said compartment in communication with the exterior of said body;

at least one playing string mounted to said body to permit said string to produce sound when it is vibrated;

a bridge contacting said string for transmitting vibration from said string to said body; and

means for converting mechanical vibration produced by said string to an electrical signal.

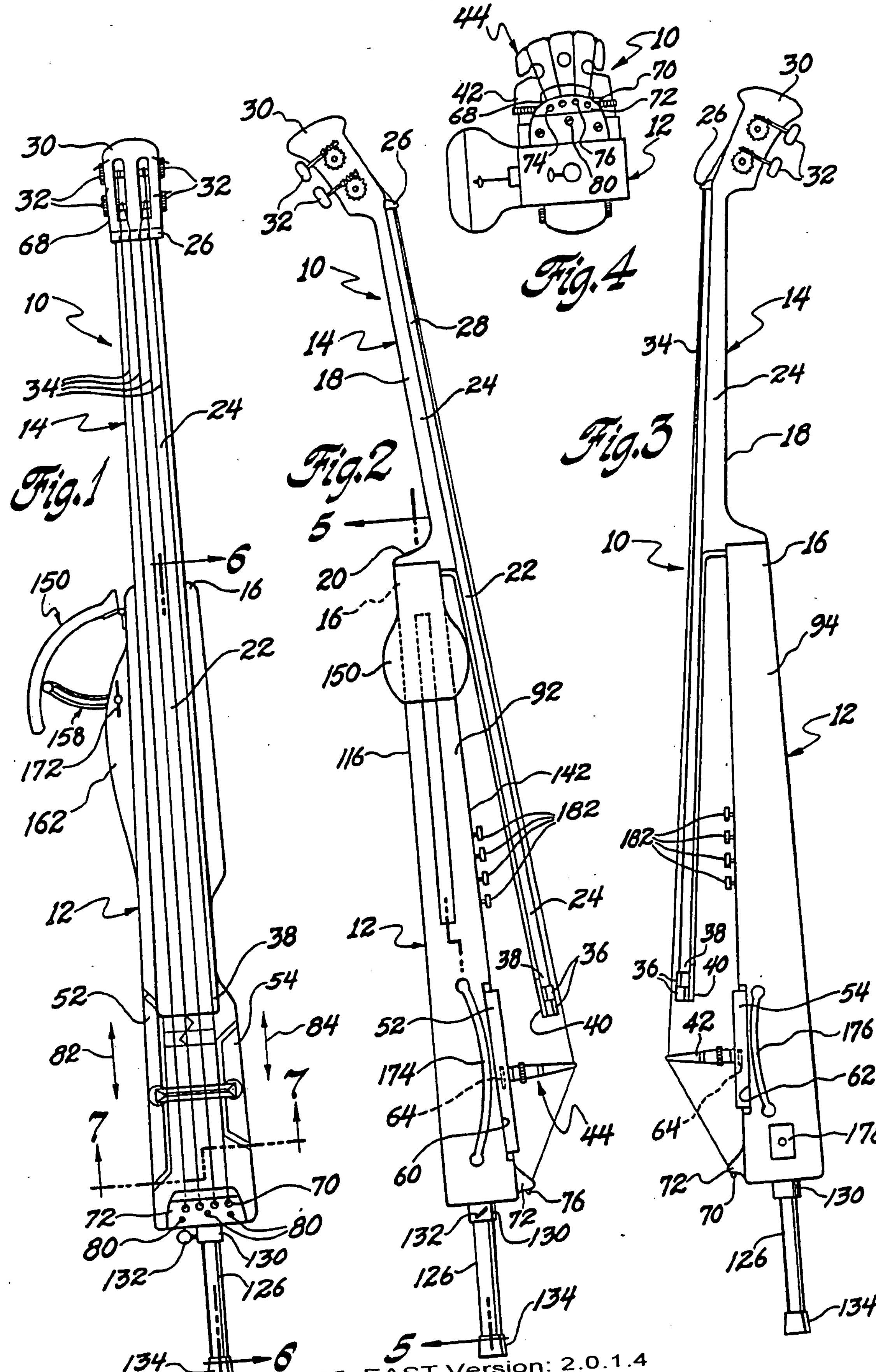


Fig.1

Fig.2

Fig.3

Fig.4

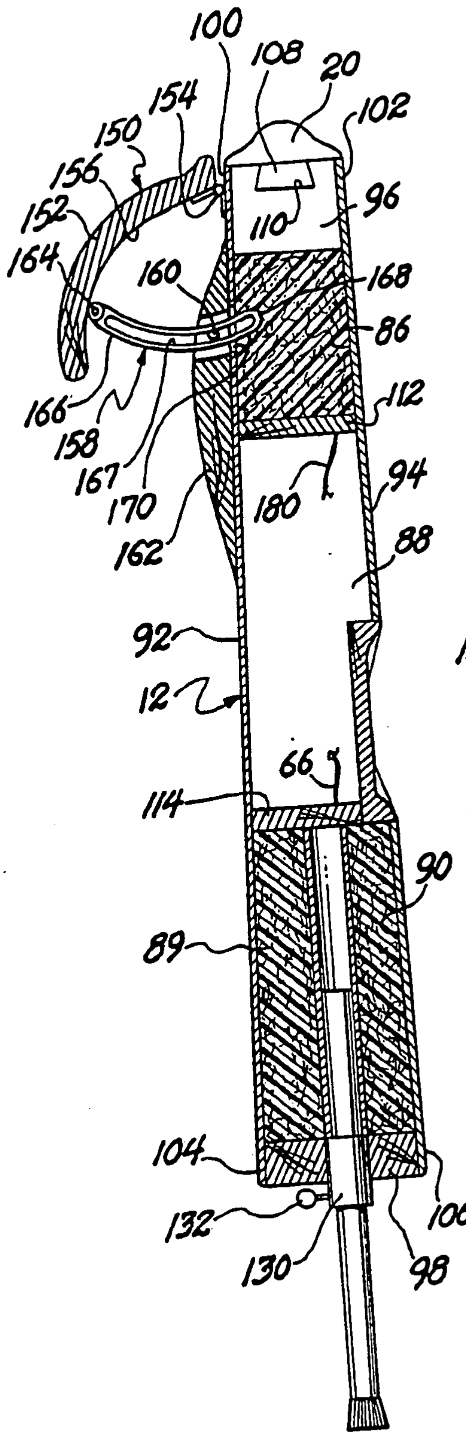


Fig.5

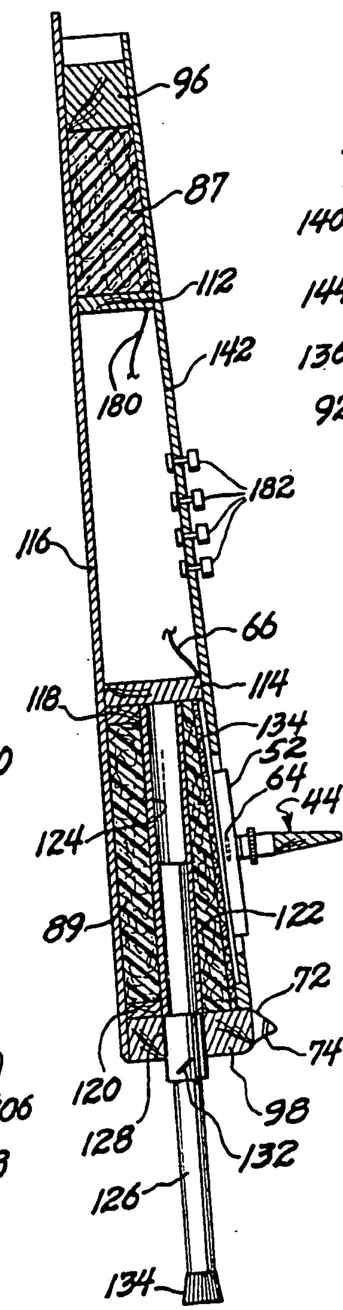
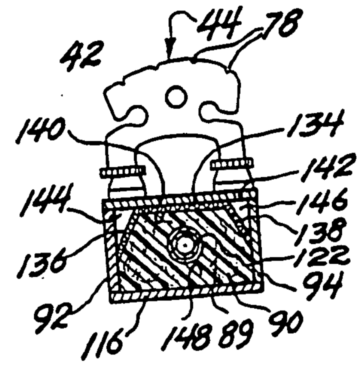


Fig.6

Fig. 7



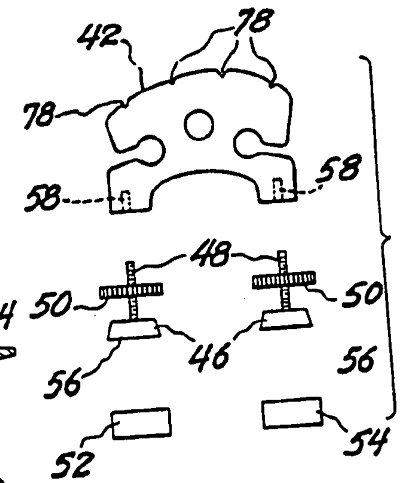


Fig.8

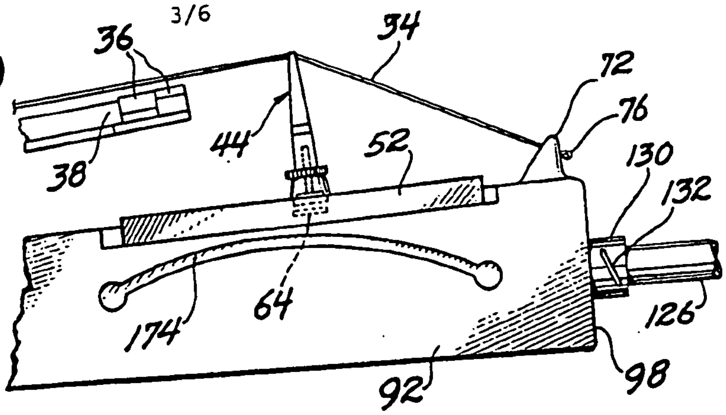


Fig.9

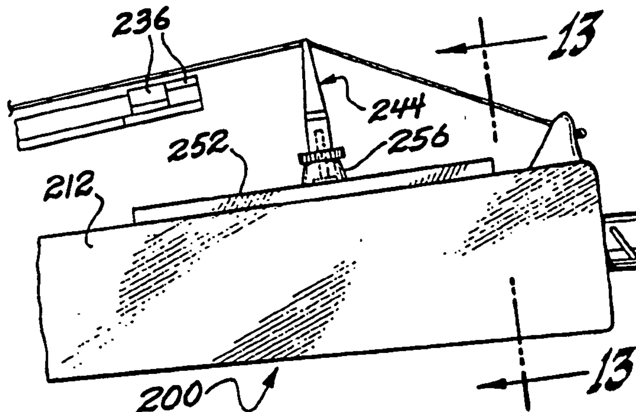


Fig.14

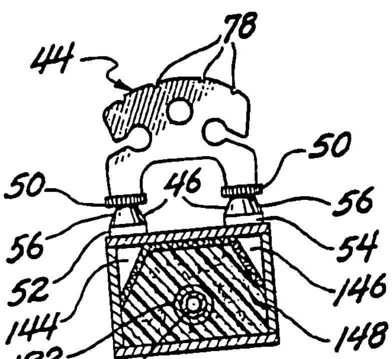


Fig.10

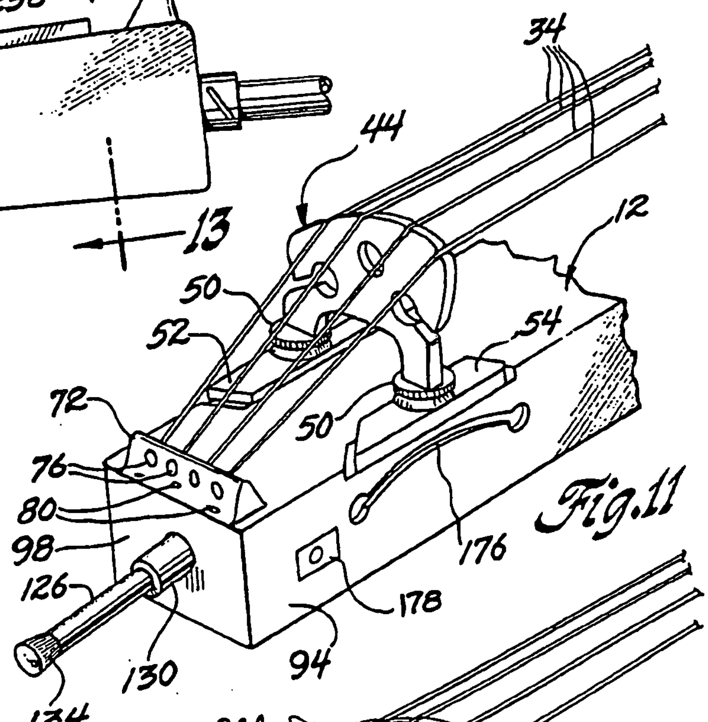


Fig.11

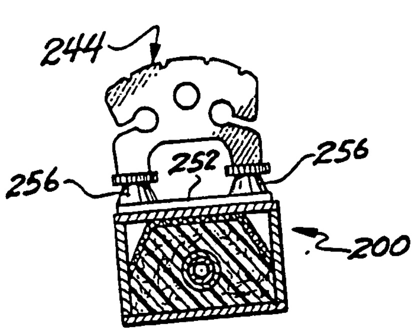


Fig.13

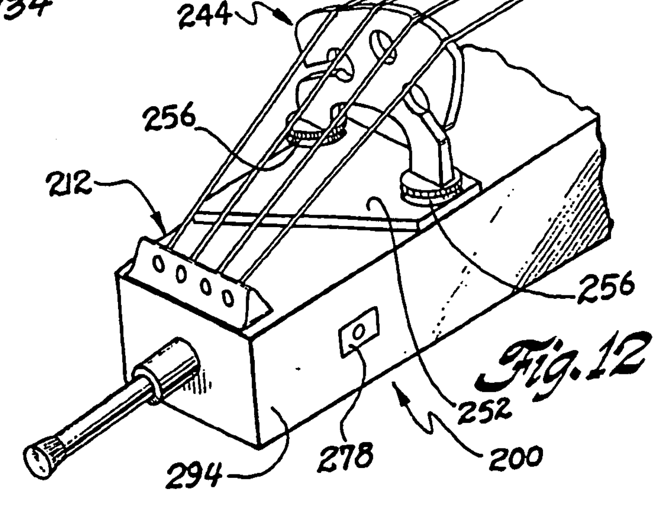


Fig.12

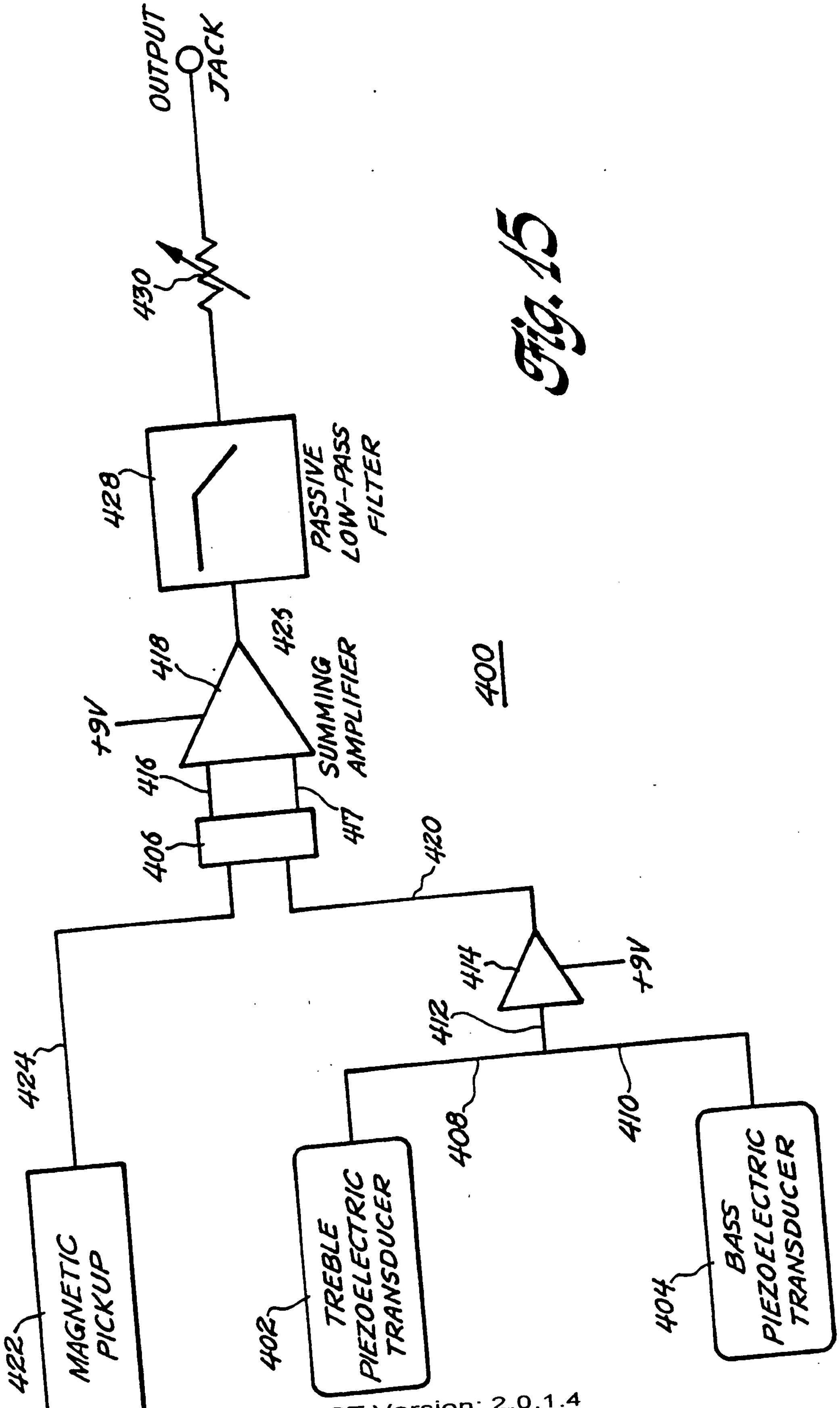

OUTPUT JACK
430
428
PASSIVE LOW-PASS FILTER
418
425
+9V
SUMMING AMPLIFIER
400
416
417
406
420
414
+9V
412
424
408
410
422
MAGNETIC PICKUP
402
TREBLE PIEZOELECTRIC TRANSDUCER
404
BASS PIEZOELECTRIC TRANSDUCER

Fig. 15

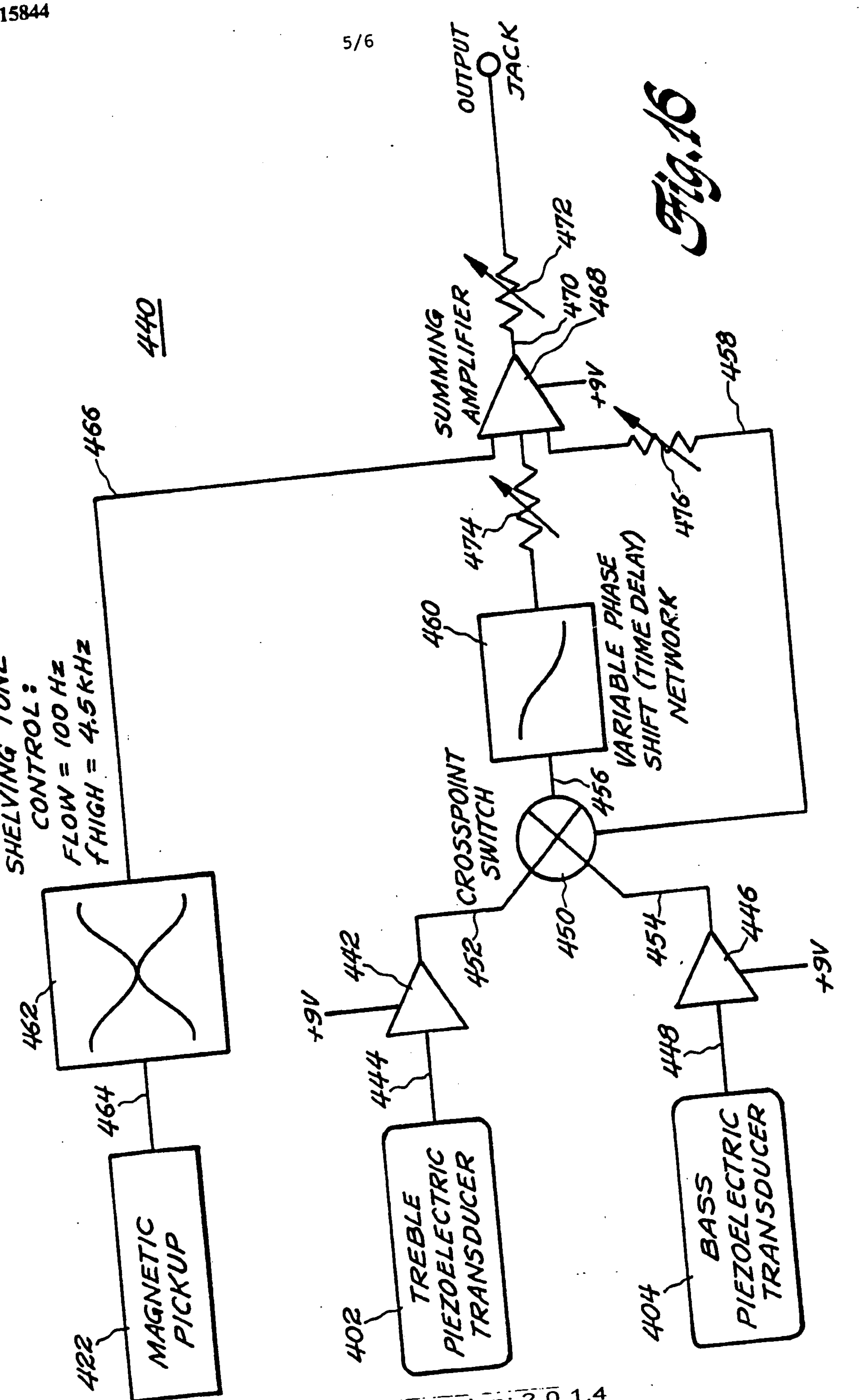

440
MAGNETIC PICKUP
422
464
462
SHELVING TONE CONTROL:
FLOW = 100 Hz
fHIGH = 4.5kHz
466
TREBLE PIEZOELECTRIC TRANSDUCER
402
444
+9V
442
452
CROSSPOINT SWITCH
450
456
BASS PIEZOELECTRIC TRANSDUCER
404
448
446
+9V
454
460
VARIABLE PHASE SHIFT (TIME DELAY) NETWORK
474
458
476
SUMMING AMPLIFIER
+9V
468
470
472
OUTPUT JACK

Fig.16

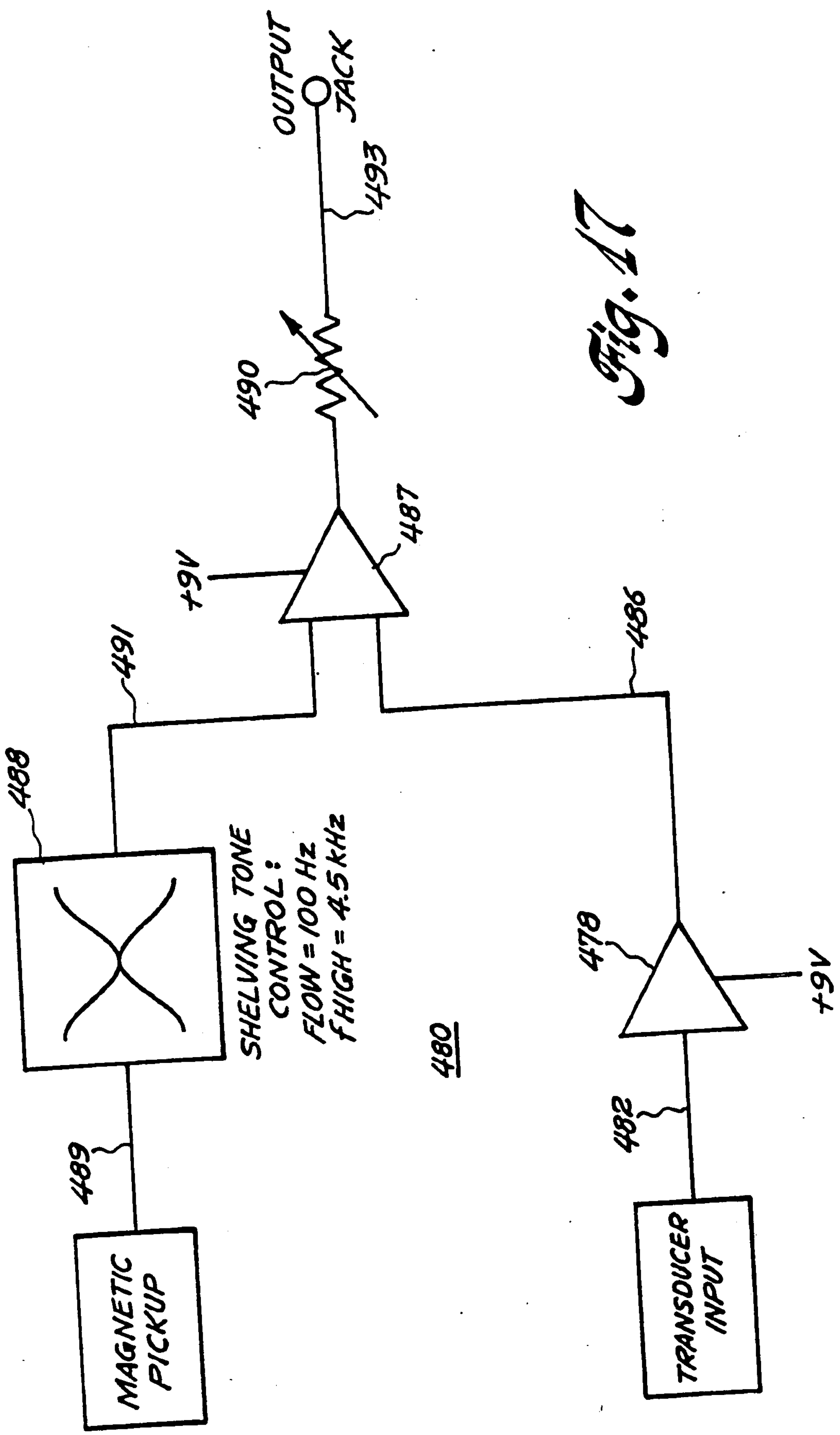

OUTPUT JACK
493
490
487
+9V
491
486
488
SHELVING TONE CONTROL:
FLOW = 100 Hz
FHIGH = 4.5 kHz
480
478
+9V
482
489
MAGNETIC PICKUP
TRANSDUCER INPUT

Fig. 17

INTERNATIONAL SEARCH REPORT

International Application No PCT/US91/02340

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC (5): G10H 3/18 3/00
U.S. CL: 84/731, 743, DIG.24

II. FIELDS SEARCHED

Minimum Documentation Searched

Classification System	Classification Symbols
U.S.	84/723,725,726,730,731,742,743,DIG 24

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched

III. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
X	US, A, 4,632,002 (CLEVINGER) 30 December 1986 see the entire document.	1
X	US, A, 3,291,887 (CARMAN ET AL.) 13 December 1966. see the entire document.	2
A,P	US, A, 4,944,209 (FISHMAN) 31 July 1990 see the entire document.	1,2
A	US, A, 4,242,938 (VAN ZALINGE) 06 January 1981 see the entire document.	1,2
A	US, A, 2,978,945 (DOPERA ET AL.) 11 April 1961. see the entire document.	1,2
A	US, A, 4,147,084 (UNDERWOOD) 03 April 1979 see the entire document.	1,2

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
21 MAY 1991	11 JUN 1991
International Searching Authority	**Signature of Authorized Officer**
ISA/US	Ngô-Hô Nguyen NGUYEN NGOC-HO JEFF DONELS INTERNATIONAL DIVISION

Form PCT/ISA/210 (second sheet) (May 1986)